

What is claimed is:

- 1        1.        A method comprising:  
2                determining a slack value for each of one or more ready instructions based on resource  
3                constraints;  
4                selecting one of the ready instructions, based on the slack value; and  
5                scheduling the selected ready instruction.  
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- 1        2.        The method of claim 1, further comprising:  
2                performing the method set forth in claim 1 until all instructions in a scheduling region  
3                have been scheduled.  
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- 1        3.        The method of claim 1, wherein:  
2                determining a slack value for each of the one or more ready instructions further  
3                comprises determining the slack value for the instruction based on resource  
4                constraints and dependence height.  
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- 1        4.        The method of claim 1, wherein determining a slack value further comprises:  
2                determining a dependence deadline based on a dependence height for the instruction;  
3                determining a resource deadline based on resource constraints for the instruction;

4 selecting between the resource deadline and the dependence deadline to choose a  
5 deadline value that indicates a least number of cycles; and  
6 determining the slack value based on the selected deadline value.

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1 5. The method of claim 1, wherein:  
2 selecting one of the ready instructions further comprises selecting a ready instruction  
3 having a lowest slack value.

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1 6. The method of claim 1, further comprising:  
2 generating an entry in a ready list for each of the one or more ready instructions; and  
3 removing the entry for the selected ready instruction from the ready list.

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1 7. The method of claim 6, further comprising:  
2 adding to an uncover list any instructions uncovered by the scheduling of the selected  
3 ready instruction.

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1 8. The method of claim 6, further comprising:  
2 advancing a virtual clock to a subsequent clock cycle; and  
3 adding an entry to the ready for list for any instruction that becomes ready in the  
4 subsequent clock cycle.

1 9. The method of claim 1, further comprising:

2 determining a minimum number of cycles needed to schedule the instructions of a  
3 scheduling region, taking resource constraints into account.

1 10. The method of claim 9, wherein:

2 the minimum number of cycles is determined to be a dependence length of the scheduling  
3 region if the scheduling region is dependence-bound; and

4 the minimum number of cycles is determined to be a resource length of the scheduling  
5 region if the scheduling region is resource-bound.

1 11. The method of claim 10, further comprising:

2 calculating the dependence length of the scheduling region based on the total height of a  
3 dependence graph of the scheduling region; and

4 calculating the resource length of the scheduling region based on the maximum number  
5 of cycles needed to schedule the instructions of the scheduling region for a machine resource.

1 12. The method of claim 1, wherein:

2 the resource constraints include the maximum number of instructions of a particular  
3 instruction type that can be scheduled during a given cycle for a selected target processor.

1 13. An article comprising:

2 a storage medium having a plurality of machine accessible instructions, which if executed  
3 by a machine, cause the machine to perform the following operations:

4 determining a slack value for each of one or more ready instructions based on resource  
5 constraints;

6 selecting one of the ready instructions, based on the slack value; and

7 scheduling the selected ready instruction.

1 14. The article of claim 13, wherein:

2 the plurality of machine accessible instructions further include instructions, which if  
3 executed by a machine, cause the machine to perform the method set forth in claim 1  
4 until all instructions in a scheduling region have been scheduled.

1 15. The article of claim 13, wherein the instructions, which if executed by a machine,  
2 cause the machine to perform determining a slack value further comprise  
3 instructions, which if executed by a machine, cause the machine to perform:

4 determining the slack value for the instruction based on resource constraints and  
5 dependence height.

1 16. The article of claim 15, wherein the instructions, which if executed by a machine,  
2 cause the machine to perform determining a slack value further comprise  
3 instructions, which if executed by a machine, cause the machine to perform:  
4 determining a dependence deadline based on a dependence height for the instruction;  
5 determining a resource deadline based on resource constraints for the instruction;  
6 selecting between the resource deadline and the dependence deadline to choose a  
7 deadline value that indicates a least number of cycles; and  
8 determining the slack value based on the selected deadline value.

1 17. The article of claim 13, wherein:  
2 instructions that cause the machine to perform selecting one of the ready instructions  
3 further comprise instructions, which if executed by a machine, cause the machine to  
4 perform selecting a ready instruction having a highest scheduling priority.

1 18. The article of claim 13, wherein the plurality of instructions further comprise  
2 instructions, which if executed by a machine, cause the machine to perform:  
3 generating an entry in a ready list for each of the one or more ready instructions; and  
4 removing the entry for the selected ready instruction from the ready list.

1 19. The article of claim 18, wherein the plurality of instructions further comprise  
2 instructions, which if executed by a machine, cause the machine to perform:  
3 adding to an uncover list any instructions uncovered by the scheduling of the selected  
4 ready instruction.

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1 20. The article of claim 18, wherein the plurality of instructions further comprise  
2 instructions, which if executed by a machine, cause the machine to perform:  
3 advancing a virtual clock to a subsequent clock cycle; and  
4 adding an entry to the ready for list for any instruction that becomes ready in the  
5 subsequent clock cycle.

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1 21. The article of claim 13, wherein the plurality of instructions further comprise  
2 instructions, which if executed by a machine, cause the machine to perform:  
3 determining a minimum number of cycles needed to schedule the instructions of a  
4 scheduling region, taking resource constraints into account.

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1 22. The article of claim 21, wherein the plurality of instructions further comprise  
2 instructions, which if executed by a machine, cause the machine to perform:  
3 determining the minimum number of cycles to be a dependence length of the scheduling  
4 region if the scheduling region is dependence-bound; and

5 determining the minimum number of cycles to be a resource length of the scheduling  
6 region if the scheduling region is resource-bound.

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1 23. The article of claim 22, wherein the plurality of instructions further comprise  
2 instructions, which if executed by a machine, cause the machine to perform:  
3 calculating the dependence length of the scheduling region based on the total height of a  
4 dependence graph of the scheduling region; and  
5 calculating the resource length of the scheduling region based on the maximum number  
6 of cycles needed to schedule the instructions of the scheduling region for a machine resource.

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1 24. The article of claim 13, wherein:  
2 the resource constraints include the maximum number of instructions of a particular  
3 instruction type that can be scheduled during a given cycle for a selected target  
4 processor.

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1 25. A compiler comprising:  
2 a front end; and  
3 a code generator;  
4 wherein the code generator includes one or more resource-aware schedulers to schedule  
5 instructions, the one or more resource-aware schedulers to take resource constraints  
6 into account to generate a slack value for each of the instructions.

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1 26. The compiler of claim 25, wherein:

2 said one or more resource-aware schedulers is further to determine a first scheduling  
3 deadline for an instruction in a scheduling region, taking dependence considerations  
4 into account; and

5 said one or more resource-aware schedulers is further to determine a second scheduling  
6 deadline for the instruction, taking resource constraints into account; and

7 said one or more resource-aware schedulers is further to select between the first and  
8 second scheduling deadlines to choose a scheduling priority for the instruction.

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1 27. The compiler of claim 25, wherein:

2 said resource-aware scheduler is further to select among ready instructions to select an  
3 instruction for scheduling.

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1 28. The compiler of claim 26, wherein:

2 said resource-aware scheduler is further to select the instruction for scheduling based on  
3 its scheduling priority.

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1 29. The compiler of claim 25, wherein:



2       said resource constraints include a maximum number of instructions that can be  
3       scheduled per cycle.

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1       30.       The compiler of claim 25, wherein:

2       said resource constraints include the maximum number of instructions of a particular  
3       instruction type that can be scheduled per cycle.

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1       31.       The compiler of claim 25, wherein:

2       the resource-aware scheduler is further to schedule the instructions such that instructions  
3       of a particular instruction type are distributed evenly among two or more resources.

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1       32.       A system comprising:

2       a processor; and

3       a memory system to store instructions;

4       wherein the instructions include a resource-aware scheduler to determine, based on  
5       resource constraints, a slack-based scheduling priority for each of one or more instructions.

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1       33.       The system of claim 32, wherein:

2       the memory system includes a DRAM.

1 34. The system of claim 32, wherein:

2 said resource-aware scheduler is further to determine a first scheduling deadline for an  
3 instruction in a scheduling region, taking dependence considerations into account;  
4 and

5 said resource-aware scheduler is further to determine a second scheduling deadline for  
6 the instruction, taking resource constraints into account; and

7 said resource-aware scheduler is further to select between the first and second scheduling  
8 deadlines to determine the scheduling priority for the instruction.

1 35. The system of claim 32, wherein:

2 said resource-aware scheduler is further to select among ready instructions to select an  
3 instruction for scheduling.

1 36. The system of claim 35, wherein:

2 said resource-aware scheduler is further to select the instruction for scheduling based on  
3 its scheduling priority.

1 37. The system of claim 32, wherein:

2 said resource constraints include a maximum number of instructions that can be  
3 scheduled per cycle.

1     · 38.       The system of claim 32, wherein:  
2               said resource constraints include the maximum number of instructions of a particular  
3     instruction type that can be scheduled per cycle.